(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(54) Title: WIRELESS COMMUNICATION DEVICE AND METHOD FOR COMMUNICATING IN SITE SELECTION DIVERSITY MODE

(57) Abstract: A wireless communication device receives CDMA signals and communicates with remote base stations in site selection diversity transmit (SSDT) mode. During communications with a primary base station, communication state parameters, such as signal to interference ratio (SIR) target values and carrier frequency estimates, are maintained for other base stations of an active set of base stations. The state parameters for communications with a selected base station are available for use after selection of a new base station. In one embodiment, the communication state parameters are used for the selection of a base from the active set.

WIRELESS COMMUNICATION DEVICE AND METHOD FOR COMMUNICATING IN SITE SELECTION DIVERSITY MODE

5

Technical Field

The present invention pertains to wireless communications, and in some embodiments, to CDMA communications, and other embodiments, to wireless

10 communication devices operating in site selection diversity transmit (SSDT) mode.

Cross-Reference to Related Applications

15 This application claims priority under 35 U.S.C. § 120 to related co-pending U. S. Patent Application entitled "METHOD AND APPARATUS FOR GENERATING A QUALITY MEASURE TARGET VALUE BASED ON CHANNEL CONDITIONS", filed December 17, 2001, having application serial number 10/021,541 and having Attorney docket number 884.654us1, which is

20 assigned to the same assignee as the present application and which is incorporated herein by reference.

Background

25 Code division multiple access (CDMA) is a technique for spread-spectrum digital communications used for many applications, including, for example, mobile communications. In CDMA systems, data signals are combined with a spreading waveform to form a coded signal for transmission. At the receiver, the received signal is combined with a similar spreading waveform to extract the data

30 signals. The technique provides high data capacity by spreading signal energy over a wide bandwidth to increase bandwidth utilization and reduce the effects of narrow band interference. Multipath effects make synchronization more difficult since the wireless channel from a base station to a reception device may have several paths of different time-delays, which may vary due to the movement of the

35 reception device.

Wireless communication devices (e.g., mobile stations), which communicate CDMA signals with remote base stations, often operate in a site selection diversity transmit (SSDT) mode for selection of base stations to communication with. One problem with SSDT mode is that some algorithms,

5   such as signal to interference ratio (SIR) estimation and frequency estimation algorithms, are unable to quickly adapt to the quick changes in channel conditions that occur when transferring communications from one base station to another. This may result in poor performance, especially after the selection of a new primary base station for communication.

10   One specific problem area is power control. Mobile stations conventionally implement power control methods to minimize transmission power while maintaining desired performance levels. Conventional power control methods implement a nested loop structure having an outer loop and an inner loop to control transmit power. In the outer loop, the block error rate (BLER) of

15   received data may be monitored and compared to a desired BLER. A SIR target is then developed for the receiver based on the comparison. In the inner loop, a measured SIR for a received signal is compared to the SIR target. A power control message may then be generated for delivery to the transmitter based on the result of the SIR comparison (e.g., indicating whether transmit power modifications are

20   desirable). A problem with this power control technique (and other similar methods) is that the BLER measurement is relatively slow and, therefore, the SIR target is not able to adapt quickly to changes in channel conditions. As may be appreciated, this may result in poor communication quality when channel conditions change faster than transmit power may be readjusted.

25

Brief Description of the Drawings

The appended claims are directed to some of the various embodiments of the present invention. However, the detailed description presents a more complete

30   understanding of the present invention when considered in connection with the figures, wherein like reference numbers refer to similar items throughout the figures and:

FIG. 1 illustrates an operational environment in which embodiments of the present invention may be practiced;

2

FIG. 2 is a block diagram of a wireless communication device in accordance with an embodiment of the present invention;

FIG. 3 is a block diagram of a SIR target generator in accordance with an embodiment of the present invention;

5   FIG. 4 is a block diagram of a carrier frequency correction unit in accordance with an embodiment of the present invention;

FIG. 5 is a flow chart of a communication procedure in accordance with an embodiment of the present invention;

FIG. 6 is a flow chart of a procedure for managing SIR targets in

10   accordance with an embodiment of the present invention; and

FIG. 7 is an illustration of SIR target management in accordance with an embodiment of the present invention.

Detailed Description

15

The following description and the drawings illustrate specific embodiments of the invention sufficiently to enable those skilled in the art to practice it. Other embodiments may incorporate structural, logical, electrical, process, and other changes. Examples merely typify possible variations.

20   Individual components and functions are optional unless explicitly required, and the sequence of operations may vary. Portions and features of some embodiments may be included in or substituted for those of others. The scope of the invention encompasses the full ambit of the claims and all available equivalents.

The present invention pertains to wireless communications, and in some

25   embodiments, to code division multiple access (CDMA) communications, and other embodiments, to wireless communication devices operating in site selection diversity transmit (SSDT) mode. The present invention also pertains to wideband CDMA (WCDMA) communications. FIG. 1 illustrates an operational environment in which embodiments of the present invention may be practiced.

30   Operational environment 100 includes mobile station 102 which may communicate with one or more base stations 104 over communication channels 110. Mobile station 102 may be implemented as any form of communication device or subsystem that may be used within a wireless communication system including, for example, a handheld communicator, a cellular base station

3

transceiver, a satellite uplink, downlink, or crosslink transceiver, a transceiver within a terrestrial wireless link, a local multipoint distribution system (LMDS) or multipoint multichannel distribution system (MMDS) transceiver, a two-way radio, transceivers within wireless local area networks (LANs), metropolitan area

5   networks (MANs), wide area networks (WANs), wireless local loop transceivers, and others.

Operational environment 100 may also include one or more reflecting objects 108, which may cause multipath reflections and frequency selective fading within the spectrum utilized by base stations 104 and mobile station 102.

10   Operational environment 100 may also include one or more in-band interfering devices (ID) 106 which generate interference within the spectrum utilized by base stations 104 and mobile station 102. Due to reflecting objects 108 and interfering devices 106, base stations 104 and mobile station 102 may experience channel fading, multipath components, and interference conditions unique to a particular

15   communication path between a base station and a mobile station. Communication channels 110 may be any form of wireless communication path, and may include, for example, CDMA and wide-band CDMA (WCDMA) communication channels.

In accordance with embodiments of the present invention, mobile station 102 receives CDMA signals and communicates with remote base stations 104 in

20   site selection diversity transmit (SSDT) mode. During communications with a primary base station, communication state parameters, such as signal to interference ratio (SIR) targets, may be maintained for base stations of an active set of base stations. The communication state parameters may be used for transferring communications to one of the base stations of the active set. In one

25   embodiment, the communication state parameters may be used for the selection of a base station from the active set. In another embodiment, the communication state parameters of the selected base station may be used for power control immediately after transferring communications. In yet another embodiment, the communication state parameters may include SIR targets and/or carrier frequency

30   estimates, which may be maintained for base stations of the active set during communications with the primary base station. In this embodiment, when transferring communications to a selected base station of the active set, the SIR target and/or carrier frequency correction for the selected base station may be used immediately after transferring communications.

4

In an alternate embodiment, communication state parameters for the base stations of the active set may be calculated when this station is selected for communication. When a base station is selected for transferring communications, the communication state parameters for the selected base station may be updated

5   for subsequent use after transferring communications.

The active set of base stations may include any base station that may be considered by a mobile station for transferring communications. The active set of base stations may include any base station of the system from which the mobile station may be capable of communicating with. The base stations of the active set

10   may be determined from power level measurements of associated pilot channels. In accordance with one embodiment of the present invention, a base station of the active set may be selected for transferring communications based on channel state parameters. This is unlike conventional systems, which select base stations for transferring communications solely based on power level measurements.

15   Accordingly, improved wireless communications may be achieved. A base station having better error performance may be selected for transferring communications because maintained SIR targets and/or carrier frequency estimates may be used for base station selection. Improved communications may be achieved more quickly after transferring communications by use of the SIR

20   target maintained for the selected base station. Furthermore, improved communications may be achieved more quickly after transferring communications because carrier frequency offset may be quickly corrected thereafter. Furthermore, a more accurate power control message based on the maintained SIR measurements may be quickly generated after transferring communications to a

25   selected base station.

In one embodiment, SIR target approximations may be based on channel conditions, including a number of signal paths and/or speed of the mobile station. In one embodiment, a primary base station may be chosen based at least on signal to noise ratios (SNRs) of the base stations. In one embodiment, a plurality of SIR

30   targets may be maintained (e.g., one target for each of the base stations of the primary set). In an alternate embodiment, a SIR target for a particular base station may be updated when the base station is the primary base station and held constant for base stations that are not the primary base station. The SIR targets may be determined by using one or more channels, such as the dedicated physical

5

data channel (DPDCH), the dedicated physical control channel (DPCCH) and/or a

common pilot channel (CPICH) of a WCDMA system. Alternatively, the SIR

target for non-primary base stations may be updated using at least in part, a

channel such as the DPCCH channel that may be constantly transmitted by the

5   particular base station.

FIG. 2 is a block diagram of a wireless communication device (WCD) in

accordance with an embodiment of the present invention. WCD 200 may be

suitable for use as mobile station 102 (FIG. 1) although other devices are also

suitable. WCD 200 may be used within a communication system implementing

10   various communication techniques, including code division multiple access

(CDMA) techniques as well as wide-band CDMA (WCDMA). WCD 200 may be

implemented as either a mobile communicator or a base station transceiver within

a communication system. When WCD 200 is implemented as a mobile

communicator, receive antenna 202 may receive spread spectrum CDMA signals

15   from one or more remote base stations. Despreader 206 despreads one or more of

the signals using CDMA despreading techniques. Rake receiver 208 isolates

various multipath components associated with a particular base station and may

combine the components coherently. Decoder 212 decodes the resulting signal.

Cyclic redundancy check (CRC) element 214 may use decoded signal information

20   from decoder 212 to detect and quantify errors (e.g., as percentage of CRC errors)

within WCD 200. Channel estimator 210 may processes the despread information

to estimate channel parameters for the corresponding channel. SIR estimator 224

may estimate a SIR of the received signal using channel parameters determined by

channel estimator 210. Any technique, including conventional techniques, for

25   estimating a SIR from channel estimates may be suitable.

SIR target generator 216 generates a SIR target based on channel estimates

from channel estimator 210 and performance estimates from CRC element 214.

Embodiments of the present invention may use any conventional SIR target

generation technique. At least one embodiment of the present invention may use

30   the SIR target generation approach described in U. S. Patent Application entitled

"METHOD AND APPARATUS FOR GENERATING A QUALITY MEASURE

TARGET VALUE BASED ON CHANNEL CONDITIONS", filed December 17,

2001, having application serial number 10/021,541, which is assigned to the same

assignee as the present application and which is incorporated herein by reference.

In accordance with embodiments of the present invention, SIR target generator 216 may also generate active set SIR targets 217 from channel estimates. Active set SIR targets 217 may represent instantaneous SIR targets for base stations of the active set. This is described in more detail below.

5   The SIR target generated by SIR target generator 216 may be compared with the SIR estimate provided by SIR estimator 224 in comparison unit 226. Message generator 228 may then generate a message, including a power control message, based upon the comparison results. The message may be transmitted to a remote base station using transmitter 230 and transmit antenna 232. A similar

10   approach may be used when WCD 200 is implemented as a base station, although receive antenna 202 may receive CDMA signals from one or more remote users rather than one or more remote base stations. Receive and transmit antennas 202, 232 may be replaced by a single antenna with the addition of duplexing functionality. Receive and transmit antennas 202, 232 may be almost any type of

15   antenna suitable for receiving and transmitting frequencies used by WCD 200. In one embodiment, receive and transmit antennas 202, 232 may be comprised of either a single or separate dipole antennas, although other types of antennas are also suitable.

        In at least one embodiment of the present invention, SIR targets generated

20   for base stations of the active set are used to support a site selection diversity transmit (SSDT) mode of operation. In this mode, a mobile station may select one of a number of different base stations to transmit to the mobile station at a particular time. For example, when the channel from one base station is fading, a mobile station operating in SSDT mode may switch to another base station whose

25   channel may not be fading. During the transition (i.e., transferring communications) from one base station to another, the channel conditions of the new base station may often be significantly different from the channel conditions of the previous base station. If the SIR target of the previous base station were used for receipt of communications from the new base station, a relatively large

30   SIR target error could result. In accordance with embodiments of the present invention, a relatively quick adjustment of the SIR target may be made for communications with the new base station. In one embodiment, a mobile station maintains SIR targets for each candidate base station during normal operation.

Thus, an approximate SIR target for a new base station may be available for use at
the time the new base station is selected.

In the past, mobile stations operating in SSDT mode would typically select
a base station based on the total power received from each candidate base.

5   However, the performance of a receiver (e.g., BLER, etc.) may not be a function
of receive power alone, but may also be a function of other channel parameters.
Disregarding this fact may result in a transition to a base station that has a higher
received power, but may result in a lower performance level. Therefore, in at least
one embodiment of the invention, a mobile station uses SIR targets that are

10   calculated using estimated channel parameters as part of a base station selection
criterion in SSDT mode.

CRC unit 214 may estimate almost any type of performance information
that may be useful for generating the SIR target for the primary base station by
target generator 216. This may include, for example, block error rate, bit error

15   rate, symbol error rate, and other performance measures. Channel estimator 210
may estimate almost any form of channel information that may be used by SIR
target generator 216 to determine SIR targets. This may include, for example, the
number of paths in the channel, the path strengths, mobile velocity, path fading
rates, symbol energy variances, variances between symbols of different blocks,

20   variance of total block energy, and/or others. In addition to the channel parameters
used by SIR target generator 216, channel estimator 210 may also estimate almost
any other channel parameters that may be required by SIR estimator 224 or other
functions within WCD 200.

WCD 200 may also include base station selector 218 which may select a

25   base station for transferring communications as part of SSDT mode operations.
Base station selector 218 may receive active set SIR targets 217 generated by SIR
target generator 216 and/or channel estimates provided by channel estimator 210.
Base station selector 218 may provide base station selection signal 219 for use by
SIR target generator 216, an embodiment of which is described in more detail

30   below. Base station selector 218 may also provide base station selection signal
219 to carrier frequency correction unit 204. Base station selector 208 may also
provide a signal to message generator 228 for use in indicating the selected base
station to a system controller.

Although WCD 200 is illustrated as having several separate elements, one or more of the elements may be combined and may be implemented by combinations of software-configured elements, such as processors including digital signal processors (DSPs), and/or other hardware elements. Unless

5   specifically stated otherwise, terms such as processing, computing, calculating, determining, displaying, or the like, may refer to an action and/or process of one or more processing or computing systems or similar devices that may manipulate and transform data represented as physical (e.g., electronic) quantities within a processing system's registers and memory into other data similarly represented as

10   physical quantities within the processing system's registers or memories, or other such information storage, transmission or display devices.

FIG. 3 is a block diagram of a SIR target generator in accordance with an embodiment of the present invention. SIR target generator 300 may be suitable for use as SIR target generator 216 (FIG. 2) although other devices may also be

15   suitable. SIR target generator 300 includes primary base station SIR target generator 302 to generate SIR target value 310 during communications with a primary base station. SIR target generator 300 may also include one or more active set SIR target generators 304 to generate one of the active set SIR targets 308 for one or more base stations when the WCD is communicating with the

20   primary base station. SIR target generators 302 and 304 may receive channel estimates from a channel estimator such as channel estimator 210 (FIG. 2), and in one embodiment, the channel estimator may provide channel estimates for more than one channel. For example, the channel estimator may provide channel estimates for a current channel with the primary base station, as well as channel

25   estimates for channels with other base stations of the active set. In this embodiment, channel estimator 210 (FIG. 2) may include more than one functional channel estimator unit.

In one embodiment, a single one of active set SIR target generator 304 may be used. In this embodiment, the single active set SIR target generator 304

30   may generate SIR targets for the various base stations of the active set in a serial fashion. In an alternate embodiment, one active set SIR target generator 304 may be employed for each base station (or a predetermined number of base stations) of the active set in which SIR targets are to be generated.

SIR target generator 300 may include management unit 306, which receives base station selection signal 312. Base station selection signal 312 may be provided by base station selector 218 (FIG. 2). In one embodiment, when a base station is selected for transferring communications, management unit 306 as

5   SIR target value 310 provides the SIR target for the selected base station. The operation of SIR target generator for managing and using SIR targets is described in more detail below (e.g., see FIG. 6).

In one embodiment, active set SIR targets 308 generated by SIR target generators 304 may be used to select a base station for transferring

10 communications. In this embodiment, base station selector 218 (FIG. 2) may receive active set SIR targets 308 from one or more of SIR target generators 304 and may select a base station for transferring communications using a selection criteria that considers the SIR for the candidate base station.

FIG. 4 is a block diagram of a carrier frequency correction unit in

15 accordance with an embodiment of the present invention. Carrier frequency correction unit 400 may be suitable for use as carrier frequency correction unit 204 (FIG. 1) although other units may also be suitable. Carrier frequency correction unit 400 provides a correction to a carrier frequency by measuring the carrier frequency in carrier frequency measuring element 406 using an output of

20 channel despreader 404. In one embodiment, channel despreader 404 may despread a pilot channel, such as a CPICH channel of a CDMA system, although other channels may be suitable for carrier frequency measurements. A carrier frequency estimation is generated by element 408 and may be stored in memory 410. In one embodiment, carrier frequencies are estimated for base stations of an

25 active set of base stations. In this embodiment, despreader 404 may despread pilot channels for the base stations in a serial or sequential fashion allowing a carrier frequency estimation for base stations in an active set to be stored in memory 410. In this embodiment, when a base station from the active set is selected for transferring communications, a carrier frequency correction for the selected base

30 station is immediately available allowing for correction of any carrier frequency offset. Accordingly, improved communications may be achieved substantially immediately after transferring communications. As illustrated in FIG. 4, other despreaders 412 correspond with despreader 206 (FIG. 2) and are not necessarily part of carrier frequency correction unit 400. Antenna 416 may correspond with

antenna 202 (FIG. 2) and is also not necessarily part of carrier frequency correction unit 400. In one embodiment, base station selection signal 419 may be received by unit 400 from base station selector 218 (FIG. 2) to select a carrier frequency correction for a selected base station.

5   FIG. 5 is a flow chart of a communication procedure in accordance with an embodiment of the present invention. Communication procedure 500 may be performed by a wireless communication device, such as WCD 200 (FIG. 2), as part of communication with base stations in an SSDT mode. Communication procedure 500 may also be performed by a wireless communication device, such

10   as WCD 200 (FIG. 2), as part of selecting a base station for transferring communications. Although the individual operations of procedure 500 are illustrated and described as separate operations, one or more of the individual operations may be performed concurrently and nothing requires that the operations be performed in the order illustrated. The various operations of

15   procedure 500 may be implemented by elements of WCD 200 as well as by processing elements and memory not separately illustrated that may be configured with software and/or firmware.

          In operation 502, a WCD communicates with a primary base station. The WCD may communicate using CDMA techniques or may communicate in

20   accordance with other conventional communication techniques. In operation 504, a power control message is generated. In one embodiment, the power control message is based on SIR estimate and SIR target 505 for the primary base station. The power control message may be generated in accordance with techniques discussed above for generating power control messages by WCD 200 (FIG. 2).

25   In operation 506, during communications with the primary base station of the active set, the WCD may maintain signal to interference ratio (SIR) target values for at least some base stations of the active set. The SIR targets may be generated by SIR target generator 300 (FIG. 3) and may correspond with active set SIR targets 308 (FIG. 3). In operation 508, carrier frequency estimates may be

30   generated and maintained for at least some base stations of the active set during communications with a primary base station. These carrier frequency estimates may be stored in a memory and may be generated by a carrier frequency estimator such carrier frequency correction unit 400 (FIG. 4).

In operation 510, a base station is selected for transferring communications from the active set of base stations. Operation 510 may use power level measurements 512 of channels from the base stations, SNR measurements, and/or may use active set SIR targets 514 generated in operation

5   506. Operation 510 may be performed by a base station selection element, such as base station selector 218 (FIG. 2) and may be performed as part of SSDT mode operations. Operation 510 may include generating a base station selection signal, such as signal 219 (FIG. 2).

In operation 516, communications are transferred to the selected base

10   station. In one embodiment, the SIR target fro the selected base station may be used. After transferring communications to a new base station, the carrier frequency may be corrected in operation 518 using the carrier frequency estimations generated in operation 508. In operation 520, the SIR target may be corrected. After transferring communications to the new base station, the WCD

15   may communicate with the new primary base station and operations 502 through 520 may be repeated. In one embodiment, a power control message may be based on the SIR target maintained for the selected base station allowing a more accurate power control message to be sent shortly after transferring communications without having to wait for error information to be generated.

20   FIG. 6 is a flow chart of a procedure for managing SIR targets in accordance with an embodiment of the present invention. Procedure 600 may be performed by SIR target generator 300 (FIG. 3) although other devices may also be suitable for performing procedure 600. Procedure 600 may be performed as an alternative to some of the operations of procedure 500 (FIG. 5) in which SIR

25   targets may be continually updated for all base stations of the active set. An embodiment in which procedure 600 is performed by SIR target generator 300 is described. In operation 602, primary base station SIR target generator 302 generates a SIR target. The SIR target may be generated using any SIR target generation technique and may use a CRC input from CRC 214 (FIG. 2) and a

30   channel estimate from channel estimator 210 (FIG. 2). As part of operation 602, primary base station SIR target generator 302 may produce SIR target output 310 for use in device 200 (FIG. 2) as previously discussed. In operation 604, primary base station SIR target generator 302 may generate an instantaneous SIR target, and in operation 606, primary base station SIR target generator 302 may use

memory 303 to store the instantaneous SIR target. In operation 608, a base station

selection input 312 may be received from base station selector 218 (FIG. 2). The

base station selection input may identify a base station from the active set which is

to become the new primary base station.

5   When no base station selection input is received is operation 608,

management unit 306 may wait until a base selection input is received. During

this time, SIR target output may still be generated by the primary base station SIR

target generator 302 as part of the normal operations of wireless communication

device 200 (FIG 2). It should be noted that in this embodiment, operation 610 is

10   not performed until a new base station is selected.

In operation 610, management unit 306 may replace the memory contents

of memory 303 with communication state parameters for the selected base station.

The memory contents may include an instantaneous SIR target and/or channel

estimates. Operation 610 may be performed in many ways.

15   In one embodiment, for example, management unit 306 may take the old

primary base station communication state parameters (e.g., from memory 303)

and store the parameters in a memory (e.g., one of memories 305) for the selected

active base station. Management unit 306 may also take the communication state

parameters relevant for the new selected base station (e.g., from one of memories

20   305), and may store the communication state parameters in memory 303 for use

by primary base station SIR target generator 302. In this way, primary base station

SIR target generator 302 now may work with the communication state parameters

for the new base station.

In another embodiment, management unit 306 may perform an update of

25   the data from the active set memory once, before putting the communication state

parameters in the primary base station SIR target generator's memory (e.g.,

memory 303). This update may be done to reflect the passing of time since the

data's last update. This update may also be done to reflect whatever information

was available for the management unit at the prior time, for example channel

30   estimates, old primary base SIR target, etc.).

Upon the completion of operation 610, the operations of procedure 600

may be repeated. During the repetition of procedure 600, the selected base station

from the active set is now the primary base station (e.g., in operation 602), and the

formerly primary base station may now be one of the base stations of the active set (e.g., for operations 604 and 606).

FIG. 7 is an illustration of SIR target management in accordance with an embodiment of the present invention. SIR target management 700 may be

5   performed by the various elements of SIR target generator 300 (FIG. 3) used in a wireless communication device, such as device 200 (FIG. 2). Primary base SIR target generator 702 may use any conventional SIR target generation method to generate SIR target 703. Primary base SIR target generator 702 may use, for example, CRC and channel estimates 701. Primary base SIR target generator 702

10   may also use memory 704 to store the instantaneous SIR target. Each time a new primary base station is selected, management unit 706 may replace the contents of the active memory with data for selected base station data. This may be done, for example, in one of two ways. In one embodiment, management unit 706 may simply take the old primary base station data (e.g., from memory 704) and may

15   store it in the active base stations memory (e.g., one of memories 708), and may take the data that is relevant for the new selected base station (from one of memories 708) and store it in the primary base target generator memory (e.g., memory 704) so that SIR target generator 702 will now work with the new base station data.

20   In another embodiment, which is similar except that management unit 706 may also perform an update of the data from the active set memory (e.g. one of memories 708) once before putting the data in the SIR target generator memory (e.g., memory 704). This update may be done to reflect the passing time since the data's last update and whatever information available for the management unit at

25   the specific time. For example, channel estimates, old primary base SIR target, etc. may be different and can be updated.

Accordingly, improved wireless communication may be achieved. A base station having better error performance may be selected for transferring communications because the maintained SIR measurements may be used for base

30   station selection. Furthermore, improved communications may be achieved more quickly after transferring communications because the communication state parameters may be used after transferring communications.

The foregoing description of specific embodiments reveals the general nature of the invention sufficiently that others can, by applying current

knowledge, readily modify and/or adapt it for various applications without departing from the generic concept. Therefore such adaptations and modifications are within the meaning and range of equivalents of the disclosed embodiments. The phraseology or terminology employed herein is for the purpose of description

5   and not of limitation. Accordingly, the invention embraces all such alternatives, modifications, equivalents and variations as fall within the spirit and scope of the appended claims.

CLAIMS

What is claimed is:

5   1. A method of communicating comprising:

        maintaining communication state parameters for at least some base

stations of an active set of base stations; and

        when transferring communications to a base station selected from the

active set in which state parameters are maintained, updating the state parameters

10   used for communicating with the state parameters maintained for the selected base

station.

        2. The method of claim 1, the element of maintaining comprising:

        maintaining carrier frequency estimates for the base stations of the active

set during communications with a primary base station; and

15   when transferring communications to the selected base station includes

correcting a carrier frequency for communications with the selected base station

using the carrier frequency estimate maintained for the selected base station.

        3. The method of claim 1 wherein maintaining the communication state

parameters includes maintaining signal to interference ratio (SIR) target values for

20   each of the base stations of the active set.

        4. The method of claim 3 further comprising using the SIR target value for

communicating with the selected base station.

        5. The method of claim 3 wherein after transferring communications to a

selected base station of the active set, the method further comprises using the SIR

25   target estimate maintained for the selected base station to generate a power control

message to send to the selected base station.

16

6. The method of claim 1 wherein during communications with the primary base station of the active set, the method includes

updating the communication state parameters of the selected base station of the active set after the selected base station is selected for transferring

5   communications; and

refraining from further updating the state parameters of other base stations.

7. The method of claim 1 wherein maintaining the communication state parameters comprises keeping the communication state parameters for base stations of the active set constant during communications with a primary base

10   station, and updating the communication state parameters of a selected base station when the selected base station is selected.

8. The method of claim 1 wherein maintaining the communication state parameters includes updating the communication state parameters for more than one base station of the active set during communications with a primary base

15   station.

9. The method of claim 3 further comprising selecting a base station from the active set for transferring communications based on the SIR target values.

10. The method of claim 9 further comprising selecting the base station from the active set for transferring communications additionally based on pilot

20   channel power level measurements for base stations of the active set.

11. The method of claim 1 wherein during communications with the primary base station, the method further comprises:

generating a SIR target for a current downlink channel from measured channel parameters;

25   generating a SIR estimate for the current downlink channel from measured channel parameters; and

combining the SIR target with the SIR estimate to generate a power control message for transmission to the primary base station,

wherein the current downlink channel is either a code division multiple access (CDMA) downlink channel or wideband CDMA (WBCDMA) downlink channel.

12. The method of claim 11 further comprising correcting the SIR target

5   with a correction factor determined from error rate information, and wherein combining comprises combining the SIR estimate with the corrected SIR target to generate the power control message.

13. The method of claim 1 wherein the method is performed by a mobile station operating in site selection diversity transmit (SSDT) mode.

10

10   14. A communication device comprising:

a memory to store maintained communication state parameters for base stations of an active set; and

a receiver to use the communication state parameters for communicating with one of the base stations of the active set selected for transferring

15   communications.

15. The device of claim 14, the receiver comprising:

a carrier frequency estimator to estimate carrier frequency offset estimates for the base stations of the active set during communications with a primary base station; and

20   a carrier frequency correction unit to correct a carrier frequency for communications with the selected base station using the carrier frequency estimate maintained for the selected base station when transferring communications to a selected base station of the active set, correcting.

16. The device of claim 14 wherein the receiver includes a SIR target

25   generator to maintain signal to interference ratio (SIR) target values for base stations of an active set, the SIR target value being used for communications with the selected base station.

18

17. The device of claim 14 wherein the receiver further comprises a message generator wherein after transferring communications to a selected base station of the active set, the message generator uses the SIR estimate maintained for the selected base station to generate a power control message to send to the

5   selected base station.

18. The device of claim 14 wherein during communications with the · primary base station of the active set, the receiver updates the communication state parameters of the selected base station of the active set after the selected base station is selected for transferring communications, and communicates with the

10   selected base station after transferring communications using the updated communication state parameters.

19. The device of claim 14 wherein the receiver updates the communication state parameters for base stations of the active set once during communications with a primary base station, and updates the communication state

15   parameters a second time for a base station of the active set selected for transferring communications.

20. The device of claim 14 wherein the receiver updates the communication state parameters for more than one base station of the active set during communications with a primary base station.

20

20   21. The device of claim 16 wherein the receiver selects a base station from the active set for transferring communications based on the SIR target values and based on pilot channel power level measurements for base stations of the active set.

22. A communication system comprising:

25   a dipole antenna to receive communications from a primary base station; a channel estimator to generate channel estimates for a communication channel with the primary base station and generate channel estimates for channels with base stations of an active set of base stations;

19

a signal to interference (SIR) target generator to generate SIR target values for the channel with the primary base station and the channels with the base stations of the active set;

a SIR estimator to generate a SIR estimate based on channel estimates for
5   a current channel; and

a base station selection unit to select a base station from the active set for transferring communications based on the SIR target values;

wherein during communications with the primary base station, the SIR target values are maintained for base stations of the active set, and when
10   transferring communications to one of the other base stations of the active set, the SIR estimate of the other base station is used for communications with the other base station after transferring communications.

23. The system of claim 22 further comprising a carrier frequency correction unit to maintain carrier frequency estimates for other base stations of
15   the active set during communications with a primary base station, and when transferring communications to one of the other base stations of the active set, to correct a carrier frequency of the other base station using the carrier frequency estimate for the other base station.

24. The system of claim 23 further comprising a message generator to
20   generate a power control message based on the SIR estimate for the current channel and the SIR target value for the current channel, wherein the current after transferring communications is channel a channel from the active set for transferring communications.

25. An article comprising a storage medium having stored thereon
25   instructions, that when executed by a computing platform, result in communicating with remote base stations in site selection diversity transmit (SSDT) mode wherein

maintaining communication state parameters for base stations of an active set; and
30   using the communication state parameters for communicating with one of the base stations of the active set selected for transferring communications.

26. The article of claim 25 wherein the instructions, when further executed by the digital computing platform result in:

maintaining carrier frequency estimates for the base stations of the active set during communications with a primary base station; and

5   when transferring communications to a selected base station of the active set, correcting a carrier frequency for communications with the selected base - station using the carrier frequency estimate maintained for the selected base station.

27. The article of claim 26 wherein the instructions, when further executed

10   by the digital computing platform result in maintaining signal to interference ratio (SIR) target values for base stations of an active set, wherein the SIR target value is used for communications with the selected base station.
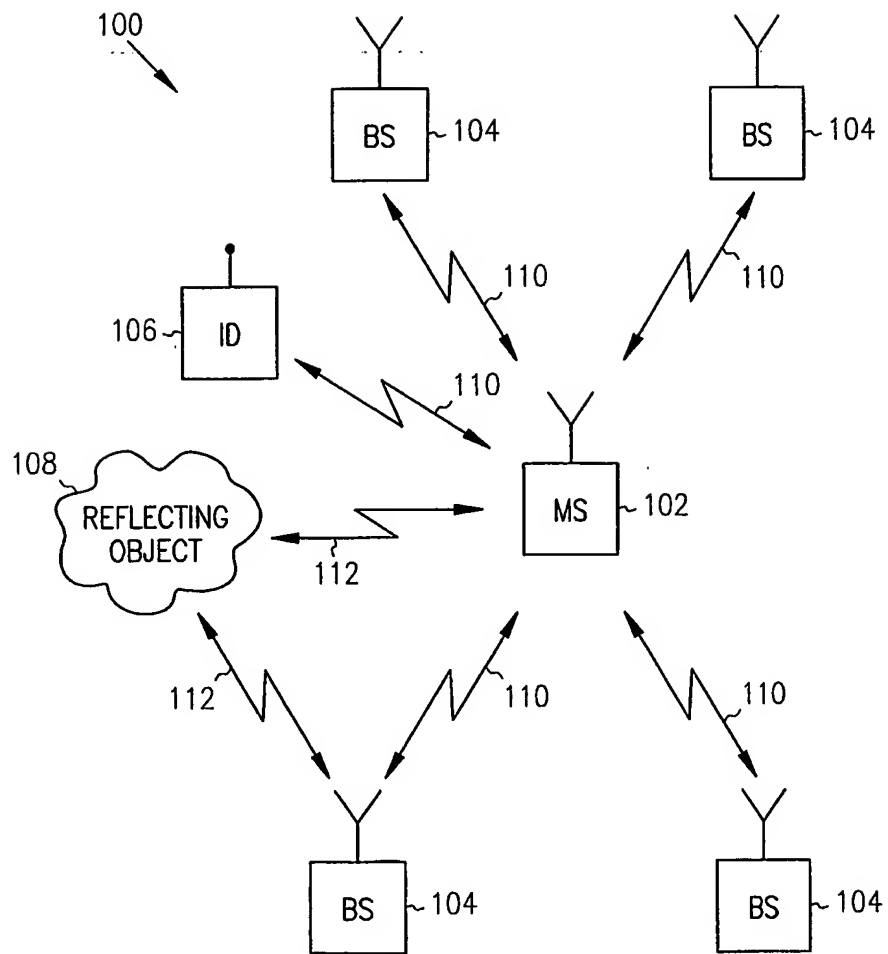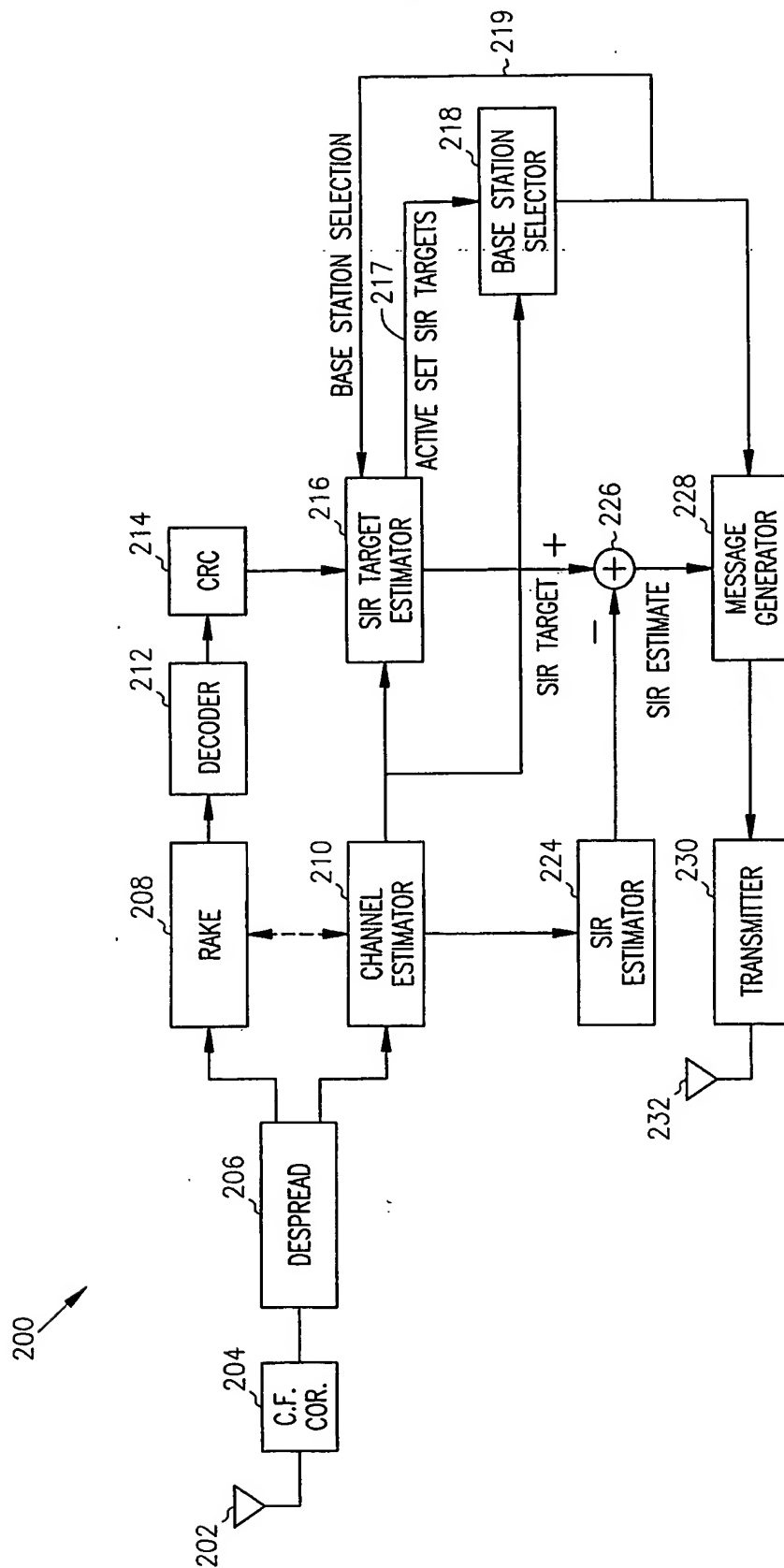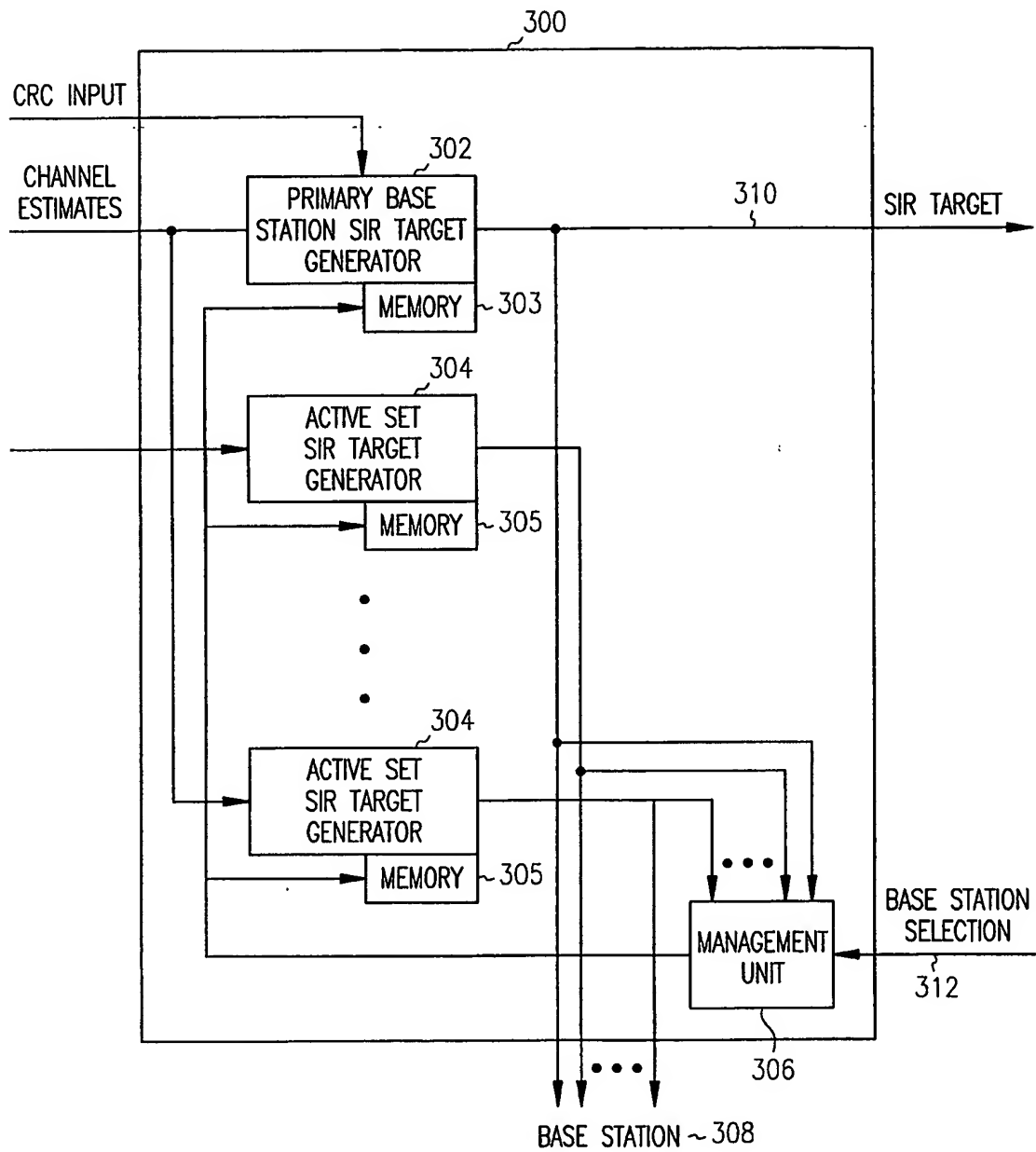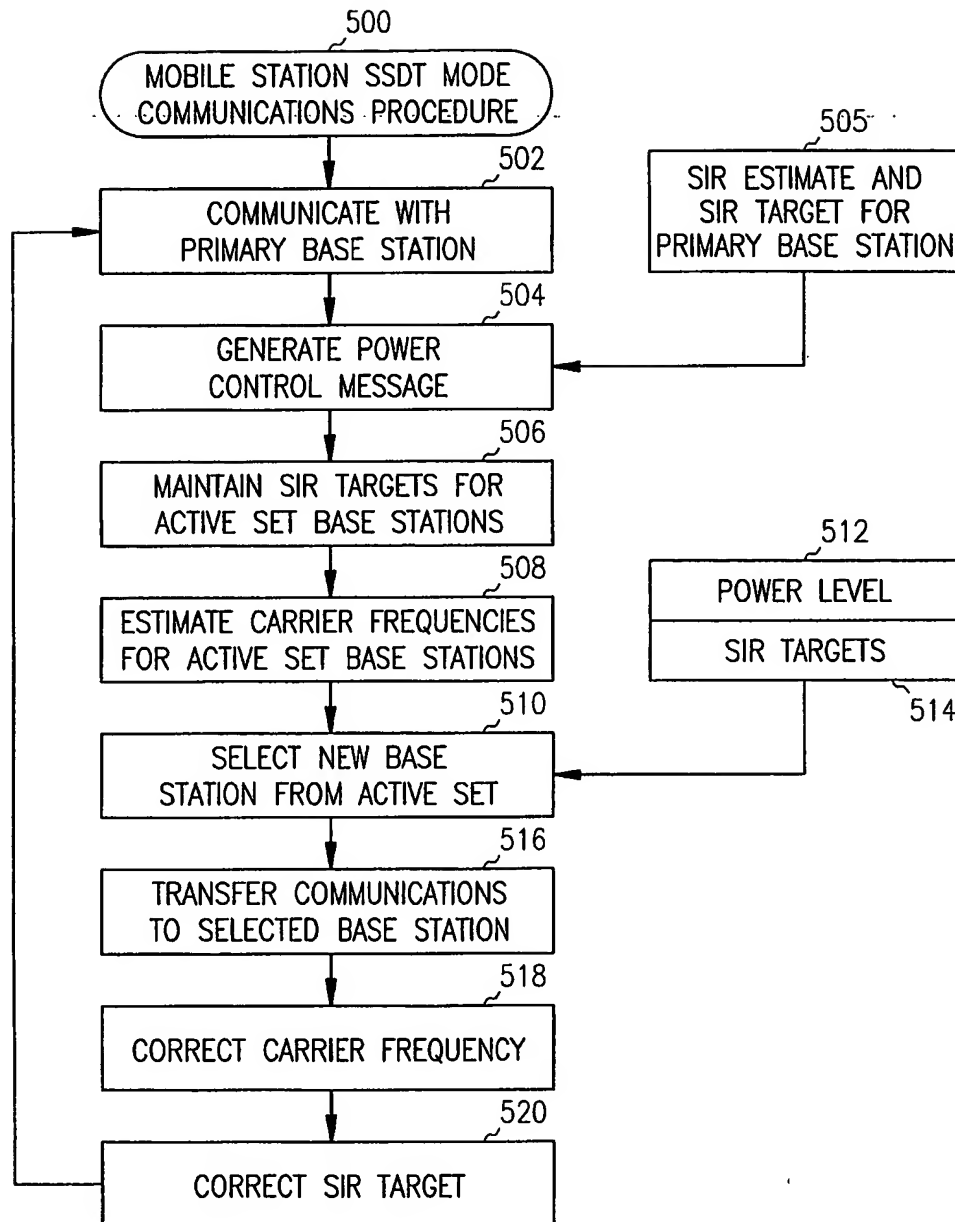
FIG. 1

FIG. 2

FIG. 3

FIG. 4

FIG. 5
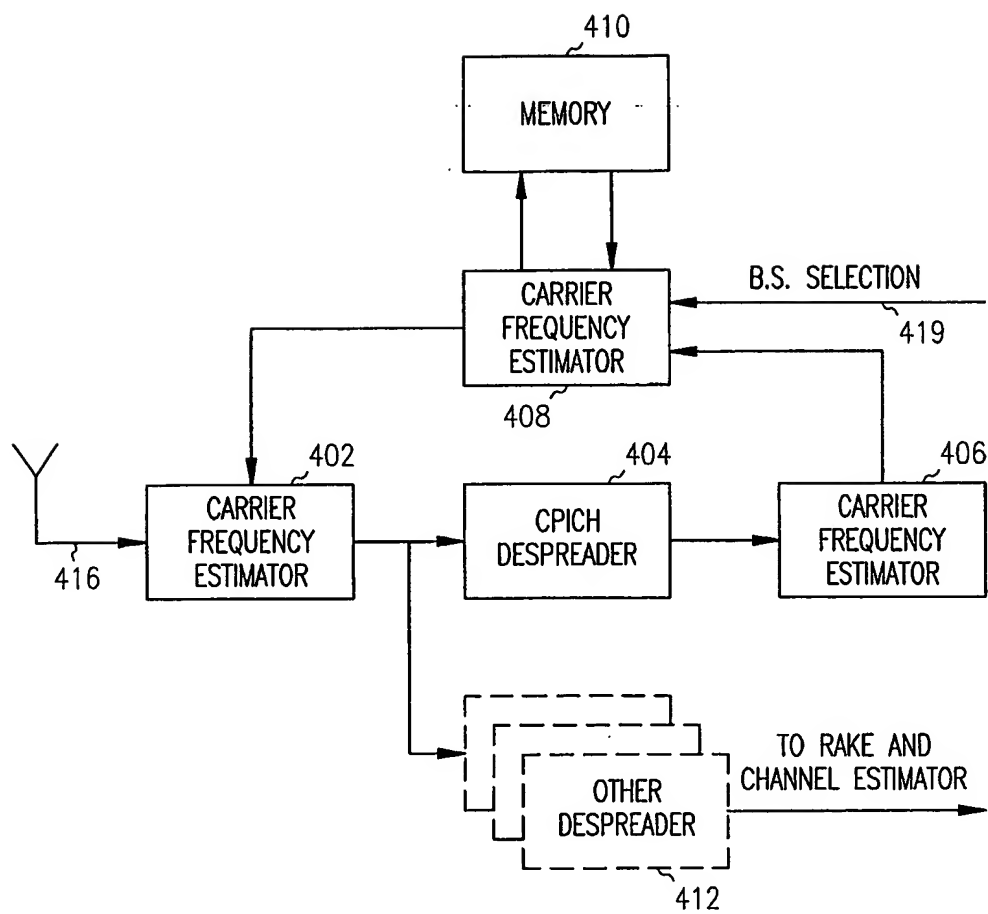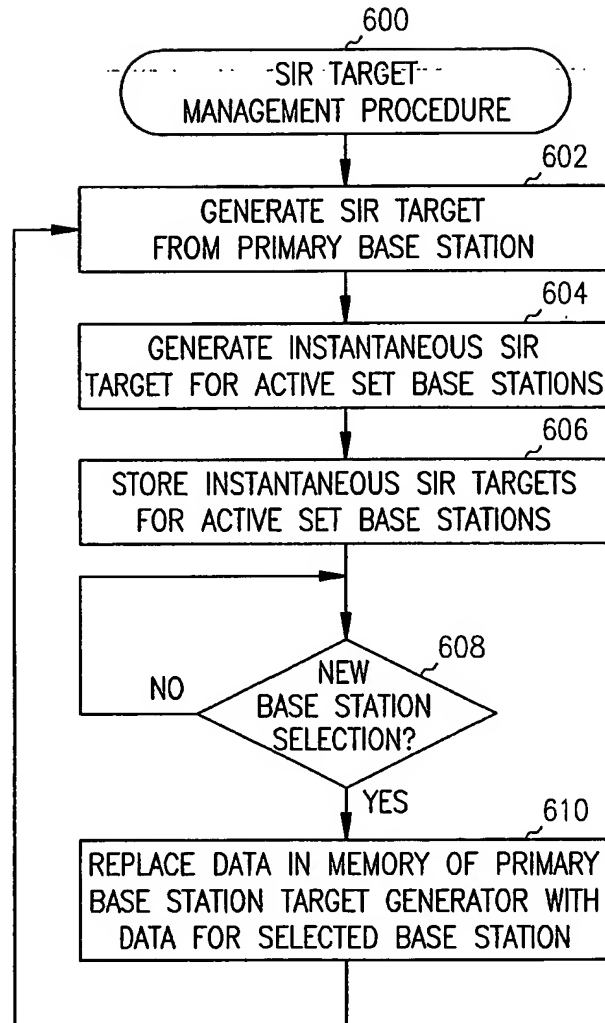
FIG. 6
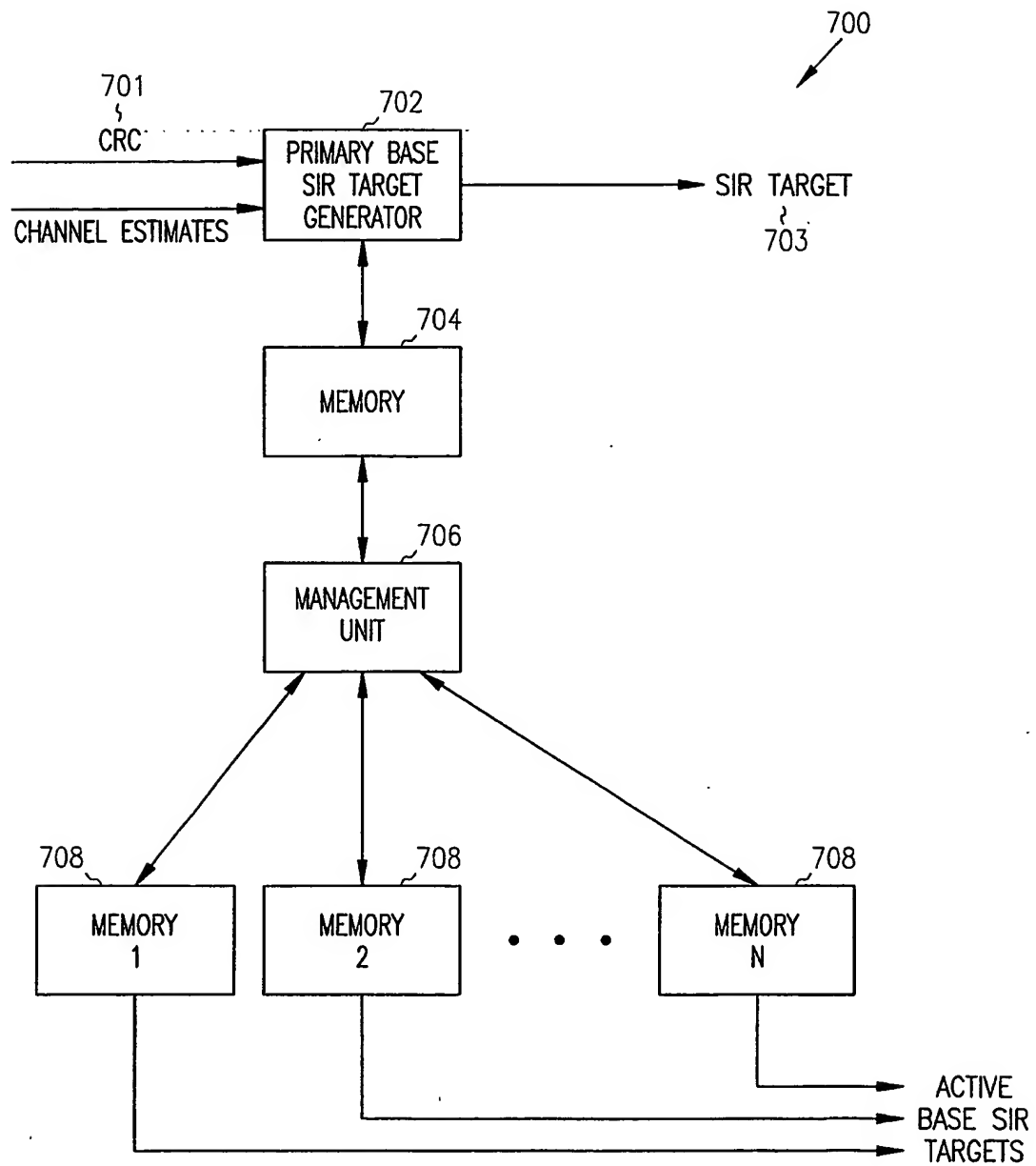
FIG. 7

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7   H04B7/005   H04Q7/38

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7   H04B   H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 167 282 A (HUNSBERGER GARY P) 26 December 2000 (2000-12-26)	1,2,6-8, 13-15, 18-20, 25,26
Y		3-5, 9-12,16, 17, 21-24,27
	column 1, line 26 – line 54 column 2, line 28 – line 52 column 3, line 22 – line 40; figure 2 column 5, line 39 – line 49; figure 4 --- -/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

'A' document defining the general state of the art which is not considered to be of particular relevance

'E' earlier document but published on or after the international filing date

'L' document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

'O' document referring to an oral disclosure, use, exhibition or other means

'P' document published prior to the international filing date but later than the priority date claimed

'T' later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

'X' document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

'Y' document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

'&' document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 May 2003	20/05/2003

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Sieben, S

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 01 01602 A (ERICSSON TELEFON AB L M) 4 January 2001 (2001-01-04) page 5, line 17 -page 6, line 4 page 6, line 20 -page 7, line 2 page 9, line 1 - line 6 page 11, line 9 -page 12, line 8; figure 5 page 15, line 1 - line 10 ---	3-5, 9-12,16, 17, 21-24,27
A	EP 1 109 330 A (NIPPON ELECTRIC CO) 20 June 2001 (2001-06-20) column 1, line 31 -column 2, line 3; figure 1 column 3, line 16 - line 29 ---	1-27
A	WO 01 24568 A (QUALCOMM INC) 5 April 2001 (2001-04-05) page 9, line 13 - line 20; figure 1D -----	1-27

INTERNATIONAL SEARCH REPORT

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 6167282	A	26-12-2000	RU	2165682 C2	20-04-2001
WO 0101602	A	04-01-2001	US	6490461 B1	03-12-2002
			AU	5261300 A	31-01-2001
			CN	1371557 T	25-09-2002
			EP	1192733 A1	03-04-2002
			JP	2003503884 T	28-01-2003
			WO	0101602 A1	04-01-2001
EP 1109330	A	20-06-2001	JP	3365379 B2	08-01-2003
			JP	2001169328 A	22-06-2001
			CA	2324727 A1	13-06-2001
			EP	1109330 A2	20-06-2001
WO 0124568	A	05-04-2001	AU	7623300 A	30-04-2001
			BR	0014397 A	20-08-2002
			CN	1377562 T	30-10-2002
			EP	1216595 A1	26-06-2002
			JP	2003510991 T	18-03-2003
			WO	0124568 A1	05-04-2001